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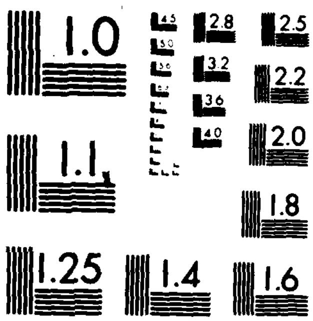

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By

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OPERATIONS TRAINING DIVISION
Williams Air Force Base, Arizona 85224

September 1983

Final Technical Paper

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SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER AFHRL-TP-83-37	2. GOVT ACCESSION NO. AD-A 132 915	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (*and Subtitle*) REAL VISUAL IMAGE COMPENSATION FOR HEAD MOTION PARALLAX EFFECTS AS A FUNCTION OF OBJECT DISTANCE		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(*s*) James M. Duff		8. CONTRACT OR GRANT NUMBER(*s*)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Operations Training Division Air Force Human Resources Laboratory Williams Air Force Base, Arizona 85224		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63227F 23630001
11. CONTROLLING OFFICE NAME AND ADDRESS HQ Air Force Human Resources Laboratory (AFSC) Brooks Air Force Base, Texas 78235		12. REPORT DATE September 1983 13. NUMBER OF PAGES 8
14. MONITORING AGENCY NAME & ADDRESS (*if different from Controlling Office*)		15. SECURITY CLASS (*of this report*) Unclassified 15.*a*. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (*of this Report*)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (*of this abstract entered in Block 20, if different from Report*)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (*Continue on reverse side if necessary and identify by block number*)

computer-image generation (CIG)
displays
image plane
parallax
real image
simulation
virtual image

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Parallax effects due to head movement cause an apparent shift of an object in an image plane. The magnitude of this shift can be determined by a simple geometric formula. Using this relationship, a real image display could provide parallax compensation similar to that of a virtual image display.

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Reviewed and submitted for publication by

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Chief, Technology Development Branch

This publication is primarily a working paper.
It is published solely to document work performed.

One of the shortcomings of current real image displays is the lack of perceived parallax due to head movement. To solve this problem, the Computer Image Generator would have to compensate for changes in viewpoint as the head moves.

Perceived parallax is a function of the following variables:

-the distance the viewpoint is shifted.

-the distance from the object to the image plane.

-the distance from the viewpoint to the image plane.

Figure 1 shows the angular parallax relationships for a shift in viewpoint parallel to the real image plane. An object at infinity appears to shift the same distance and in the same direction that the viewpoint is shifted ($S_{oo}=S$). However, a finite distance object would not appear to shift as far. The ratio of the apparent shift of a finite distance object to the apparent shift of an infinite object (S_i/S) is shown by calculations to be:

$$S_i/S = I/(I+D)$$

Figure 2 plots the ratio S_i/S as a function of object distance for a fixed 1m. distance from viewpoint to image plane (similar to the Advanced Simulator for Pilot Training). From this graph we see that the apparent shift of objects at distances greater than 30 m. would not differ significantly from the shift of an object at infinity. (S_i/S = 1.0 for 1 30m)

These results indicate that an adequate means to compensate for head movement parallax might be to shift the entire real image by the magnitude of the vector component of head movement parallel to the image plane. Parallax correction would then be similar to that of a virtual image display. Although parallax compensation error would exist for close objects, this error would diminish, becoming imperceptible for objects at distances greater than 30m.

It is recommended that a study be initiated to determine the training effectiveness of a real image display incorporating head parallax compensation as described above. If proven feasible, virtual image displays, with their inherent transmission loss due to collimating optics, could be replaced by real image displays, resulting in an increase in brightness.

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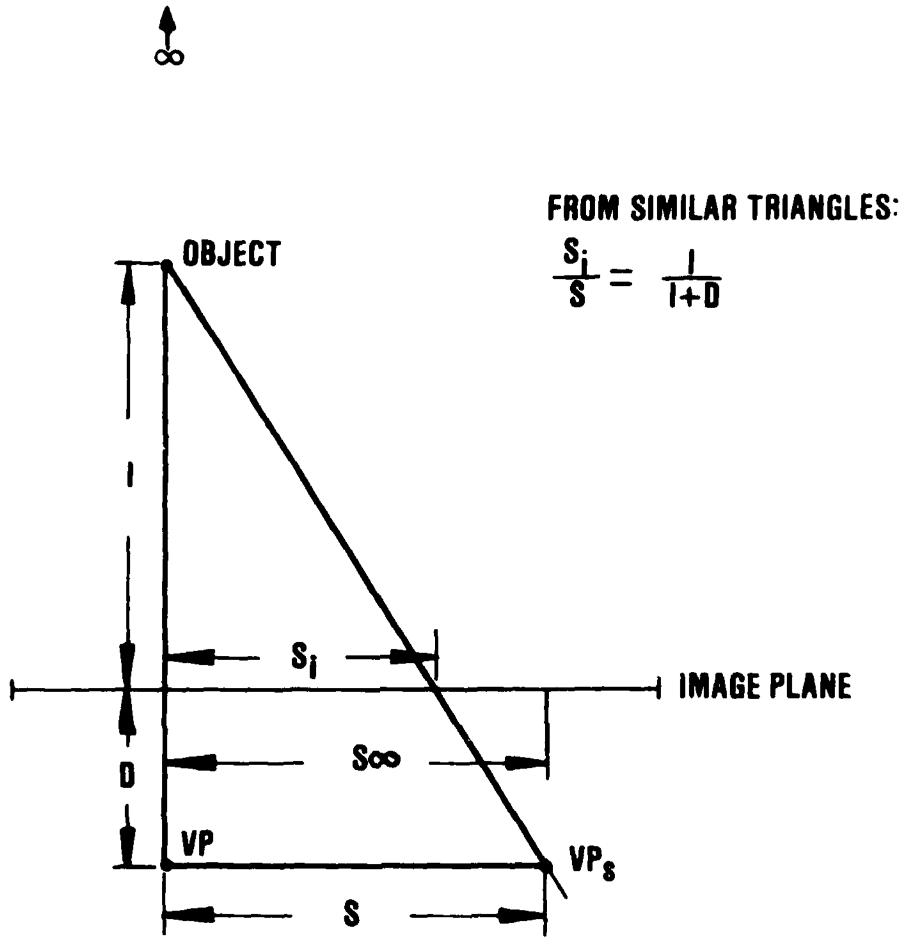

VP - ORIGINAL VIEWPOINT

VP_s - SHIFTED VIEWPOINT

D - DISTANCE FROM VIEWPOINT TO IMAGE PLANE

I - DISTANCE FROM OBJECT TO IMAGE PLANE

S_i - APPARENT SHIFT OF OBJECT; IN IMAGE PLANE AS VIEWPOINT IS SHIFTED.

FIGURE 1

ANGULAR PARALLAX RELATIONSHIPS

FOR A SHIFT IN VIEWPOINT

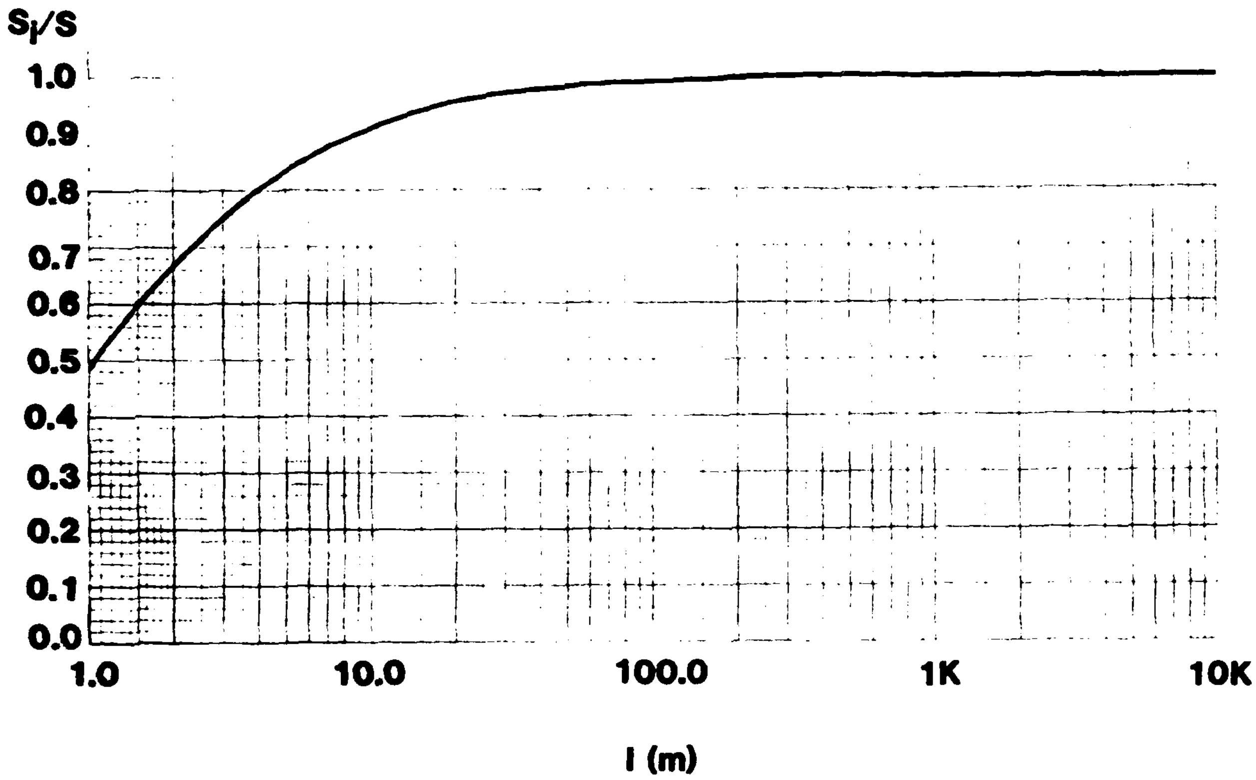

FIGURE 2

S_l/S Vs. l For D = 1.0m